The following describes particular conditions under which a reactor can be operated in order to achieve reduction in average degree of polymerization values for the pulp without substantially decreasing the hemicellulose content or increasing the copper number of the incoming pulp. It should be understood that variations from the conditions described above can be made in order to optimize the process to provide the desired product.

Examples of oxidants that can be employed have been described above. Preferred oxidants include hydrogen peroxide alone or a combination of oxygen and hydrogen peroxide. The amount of oxidant employed should provide the desired D.P. reduction and lignin removal given the time and temperature conditions employed. Examples of suitable ranges for oxygen and hydrogen peroxide are given below. Preferably, for a high consistency reactor, the oxygen is present in an amount ranging from about 0 to the maximum pressure rating for the reactor, preferably about 0 to about 85 psig, and more preferably, from about 40 to about 60 psig. The hydrogen peroxide may be present in an amount ranging from greater than about 0.75 weight percent up to about 5.0 weight percent, more preferably about 1.0 to about 2.5 weight percent.

In medium consistency reactors, the oxygen can be present in an amount ranging from about 0 to about 100 pounds per ton of the pulp, more preferably, about 50 to about 80 pounds per ton of pulp. The hydrogen peroxide may be present in an amount ranging from greater than about 0.75 weight percent up to about 5 weight percent, more preferably from about 1.0 to about 2.5 weight percent.

The temperature at which the reactor is operated will in part depend upon the concentration of the oxidants. When the oxidants are used in amounts that fall within the ranges described above, temperatures on the order of about 110°C up to about 130°C are suitable. It should be understood that the temperature in the reactor may vary over time as the reactions that occur therein tend to be exothermic which will most likely result in an increase of the temperature of the reactor. It should be understood that temperatures and oxidant concentrations falling outside the ranges described above may still provide suitable results depending on the various permutations of the amounts of oxidant used and the temperature.

In accordance with the present invention, the stage or stages used to reduce the average degree of polymerization of the pulp without substantially decreasing the hemicellulose content or increasing the copper number of the pulp remains alkaline through the stage or stages. Preferably, the pH of the stage or stages used to achieve the D.P. reduction described above is greater than about 8.0 and more preferably greater than about 9 throughout the D.P. reduction process. It should be understood that pHs above or below the noted ranges may provide satisfactory results if the temperature or concentration of oxidant is modified as necessary.

In accordance with the present invention, it is preferred that contact between the pulp and the oxidant occur prior to any acid wash or chelation stage normally used to remove transition metals. Unlike prior art processes which intentionally sought to remove transition metals which were believed to result in decomposition of hydrogen peroxide into cellulose-degrading intermediates that negatively impacted the viscosity of the cellulose, applicants have discovered that they can take advantage of the presence of naturally occurring transition metals in the wood to partially degrade the hydrogen peroxide to produce intermediates that react with the cellulose to reduce its average degree of polymerization without substantially decreasing the hemicellulose content or increasing the kappa number. In addition, unlike prior art processes that use magnesium sulfate as a means of inhibiting the degradation of cellulose, applicants prefer not to introduce magnesium sulfate into the reactor or upstream therefrom so that the pulp is contacted with the oxidant(s) in the substantial absence of an inhibitor to the degradation of the cellulose by the oxidant. If magnesium sulfate is present in the pulp prior to the reactor, it is preferred that the ratio of magnesium to the transition metals be less than 50% on a weight percent basis.

In addition to the oxidants, caustic is preferably contacted with the pulp in the reactor as a buffering agent. The source of caustic can be sodium hydroxide or other materials such as unoxidized white liquor or oxidized white liquor. The amount of caustic added will depend in part upon the kappa number of the untreated pulp. Generally, as the kappa number increases, more caustic is added. The amount of caustic introduced can vary depending on process conditions, with an amount of 4 to 5 weight percent or a greater being suitable.

When wood pulp containing cellulose and at least 7% hemicellulose having a copper number of about 2 or less is contacted with an oxidant under the conditions set forth above, a treated pulp is produced having a D.P. ranging from about 200 to about 1,100, containing at least 7% by weight hemicellulose, having a copper number less than about 2 and a ΔR of less than about 2.8. It should be understood that the description above of particular conditions under which a bleached or unbleached wood pulp can be contacted with an oxidant to reduce its average degree of polymerization without substantially reducing the hemicellulose content or increasing the copper number are exemplary and that other conditions can provide suitable results and still fall within the scope of the present invention. In addition, it should be understood that in some situations, the pulp exiting the D.P. reduction stage may be suitable for use in producing a dope for manufacture of lyocell fibers; however, in other situations, subsequent process stages such as bleaching stages may be desirable provided that subsequent stages do not result in a significant decrease in the hemicellulose content or a significant increase in the copper number of the pulp. In addition, as noted above, in some situations, it may be necessary or advantageous to subject the pulp which has been exposed to an oxidant in a first stage to a second or even third stage of contact with an oxidant in order to further reduce the degree of polymerization of the cellulose without substantially reducing the hemicellulose content or increasing the copper number thereof.

Again with reference to FIGURE 1, once the alkaline pulp has been treated with oxidants in a reactor in accordance with the present invention, the treated pulp can either be washed in water and transferred to a bath of organic solvent, such as NMMO, for dissolution prior to lyocell molded body formation, or the treated pulp can be washed with water and dried for subsequent packaging, storage and/or shipping. Alternatively, the treated, washed pulp can be dried and broken into fragments for storage and/or shipping.

A desirable feature of the treated pulps of the present invention is that the cellulose fibers remain substantially intact after treatment. Consequently, the treated pulp has a freeness and a fines content that are similar to those of the untreated pulp.

Another desirable feature of the treated pulps of the present invention is their ready solubility in organic solvents, such as tertiary amine oxides including NMMO.